

**UNITED STATES PATENT  
APPLICATION**

**Phosphors Formulation For  
Fluorescent Lamps**

Be it known that I, FRED M. MENDELSON, a citizen of the United States of America and a resident of Tampa in the State of Florida, have invented new and useful improvements in the above entitled invention the following of which is a specification in full, clear and exact terms to enable one skilled in the art to make and use the same.

EL 999677908US

## CROSS REFERENCE APPLICATION

This is a non-provisional patent application of provisional patent application  
Serial Number 60/520217, filed November 14, 2003.

## BACKGROUND OF THE INVENTION

### 5    **Field of the Invention**

A combination of phosphors formulated to coat the inside of a fluorescent  
lamp.

### **Description of the Prior Art**

Historically, the output of artificial lighting has been measured for photopic  
10    content of the light while generally ignoring the effect of the scotopic content.

The process of selecting and combining phosphors for fluorescent lamps is not  
new or unique. Unfortunately, however, relatively recent scientific knowledge  
relating to visual acuity and fluorescent technology has not been effectively applied  
commercially.

15        Research has demonstrated that by fine tuning the light spectrum, light levels  
can be reduced without compromising visual acuity and color response. Due to the  
physiological aspects of the eye, it is possible to decrease light levels without  
reducing performance by controlling the spectral distribution of artificial lighting. As a  
result energy savings achieved by relative efficacy of light production (lumens) of  
20    spectrally modified lamps.

In particular, the retina of the eye has both rod and cone receptors. The rods  
operate at low light levels, the cones operate at high light levels, and both operate  
over a range at intermediate light levels. Rods (night vision) do not provide color

response or high visual acuity. On the other hand, cones provide color vision and the acuity necessary for reading and seeing small detail.

Photopic lumens are based on cone sensitivity, while scotopic lumens are based on rod sensitivity. In photopic conditions, wavelengths near 550 nanometers appear to be brighter than those near 500 nanometers. The reverse is true in scotopic conditions where wavelengths near 510 nanometers are brighter than those near 550 nanometers.

For example during the day, yellow objects appear lighter, but as the sun goes down and the scotopic comes into play green objects appear lighter. At dusk, illumination is low enough for the scotopic effect to operate, but still high enough for the photopic to also operate.

Since cones and rods both contribute to visual acuity S/P (scotopic/photopic ratios) are a useful tool in analyzing the effectiveness of a light source on visual acuity.

Examples of past efforts to improve the source of indoor lighting are found in numerous patents.

U.S. 3,670,193 describes electric lamps having spectral radiation characteristics approximating natural daylight with a controlled amount of energy in the near and middle ultraviolet ranges which also produce light of sufficient intensity and proper color to make them usable as general illuminants.

U.S. 4,891,550 teaches a full spectrum fluorescent lamp having a phosphor coating for producing visible light having a high color rendering index and balanced

amounts of ultraviolet energy at the same correlated color temperature in which the coating is formed of two groups of phosphors.

U.S. 4,174,294 shows a fluorescent material comprising an alkaline earth metal boron phosphate activated by a divalent europium compound.

5 U.S. 5,122,710 describes a phosphor blend for a fluorescent lamp having four rare earth phosphors each of which emits a narrow band of visible light energy in the visible spectrum. The color of the light produced by three of the phosphors is red, blue and green. The fourth phosphor producing light in the blue-green range improves the color rendering index of the visible light output without seriously  
10 affecting the lumen output as compared to a blend in which only the red-blue-green phosphors are used. A fifth rare earth narrow band phosphor capable of producing energy in the ultraviolet A range can be added to the blend when it is desired to simulate various phases of natural daylight. The band of ultraviolet range energy produced can be smoothed by adding to the blend another phosphor capable of  
15 producing energy in the ultraviolet range.

Regardless of these efforts there remains a need to develop a combination of phosphors for use in a fluorescent lamp to emit a wavelength of light optimized for human visual acuity which is optimized at about 510 nanometers. At this wavelength, the amount of scotopic lumens that affects the rod receptors in the eye  
20 is maximized. The light emitted from this phosphor combination causes the pupils of the eye to contract without the presence of painful glare and an overabundance of bright light, thereby enabling the human eye to see with greater clarity, efficiency

and better focus. This optimal efficiency of the human eye generated by the high scotopic lumens, is produced in an environment of lower photopic lumens, which normally would be construed as lower ambient light, thereby utilizing less electrical energy than comparable lighting sources.

## SUMMARY OF THE INVENTION

The present invention relates to a composition of phosphors formulated to coat the inside of a fluorescent lamp to enhance effective pupil lumens for improved human visual acuity.

5           The selection, combination and utilization of certain rare earth phosphors can be formulated for use in a fluorescent lamp to peak length of about 510 nanometers. The light emitted from such a phosphor combination causes the pupils of the eye to contract without the presence of painful glare and an over abundance of bright light, enabling the human eye to see with greater clarity, efficiency and better focus. This  
10          optimal efficiency of the human eye generated by the high scotopic lumens is produced in an environment of lower photopic lumens, which normally would be construed as lower ambient light, thereby utilizing less electrical energy than comparable lighting sources.

          The formulation of phosphor combination of the present invention comprises  
15          seven phosphors, which when emulsified and used to coat the inside of a fluorescent lamp, will emit light in a wavelength from about 505 nanometers to about 515 nanometers which has been demonstrated to be the optimal wavelength for human visual acuity. The seven phosphors are strontium boride, yttrium oxide, barium  
          yttrium oxide, europium, terbium, barium borate and calcium.

20          This combination of phosphors results in a power distribution including a major peak, a minor peak separated by a trough.

          The process of emulsifying the phosphors comprises of creating a binder with water and polyethylene chloride with an adhesive slurry. After the binder has

blended, phosphors are added to the binder. The pH is elevated, and the mixture is blended. At completion of the blending the mixture is filtered and is suitable for coating fluorescent lamps.

The invention accordingly comprises the features of construction, combination  
5 of elements, and arrangement of parts which will be exemplified in the construction hereinafter set forth, and the scope of the invention will be indicated in the claims.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

For a fuller understanding of the nature and object of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings in which:

5            Figure 1 is a graph showing the power distribution of the present invention.

             Figure 2 is a tabular representation of various lamps and operating characteristics.

             Similar reference characters refer to similar parts throughout the several views of the drawings.



## **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

The present invention relates to a composition of phosphors formulated to coat the inside of a fluorescent lamp to enhance effective pupil lumens for improved human visual acuity. Studies have determined that human visual acuity is a function of both scotoopic and photopic lumens. It has been observed the visual acuity is optimized at a light wavelength of about 510 nanometers. At this wavelength, the amount of scotopic lumens which affects the rod receptors in the eye is maximized.

The selection, combination and utilization of certain rare earth phosphors can be formulated for use in a fluorescent lamp to peak length of about 510 nanometers. The light emitted from such a phosphor combination causes the pupils of the eye to contract without the presence of painful glare and an over abundance of bright light, enabling the human eye to see with greater clarity, efficiency and better focus. This optimal efficiency of the human eye generated by the high scotopic lumens is produced in an environment of lower photopic lumens, which normally would be construed as lower ambient light, thereby utilizing less electrical energy than comparable lighting sources.

The selecting and combining of various phosphors for use in fluorescent is not new or unique. Unfortunately, the combination of the body of scientific knowledge surrounding visual acuity with fluorescent technology, to produce a light emitter that helps people to see as well as the human eye can see, has not been done commercially. Heretofore, the proper combination of phosphors that could yield the result of light emitted at the optimum wavelength of about 510 has been unknown.

The formulation of phosphor combination of the present invention comprises seven phosphors, which when emulsified and used to coat the inside of a fluorescent lamp, will emit light in a wavelength from about 505 nanometers to about 515 nanometers which has been demonstrated to be the optimal wavelength for human visual acuity. The seven phosphors are strontium boride, yttrium oxide, barium yttrium oxide, europium, terbium, barium borate and calcium in relative proportions as shown in Table 1 below.

TABLE 1

<u>Compound</u>	<u>Formula</u>	<u>Element Color(s)</u>	<u>Percentage by Weight</u>
Strontium Boride	SrB <sub>6</sub>	Red/Green	46%
Yttrium Oxide	Y <sub>2</sub> O <sub>3</sub>	Red	24%
Barium Yttrium Oxide	Ba <sub>4</sub> Y <sub>2</sub> O <sub>7</sub>	Green/Red	24%
Europium	Eu	Red	2%
Terbium	Tb	Green	2%
Barium Borate	Ba <sub>4</sub> B <sub>2</sub> O <sub>7</sub>	Green	1%
Calcium	Ca	Yellow	1%

As shown in FIG. 1, this combination of phosphors results in a power distribution having a major peak of at least 30 percent of the total power at about 510 nanometers, a minor peak of at least 15 percent of the total power at about 610 nanometers and a trough of less than 10 percent of the total power at about 575 nanometers. As depicted, the percentage of power at the major peak is at least 5 times the percentage of power at the trough and at least 1.5 times the percentage of power at the minor peak.

Figure 2 illustrates the relative effectiveness of the present invention referred to as Ott-Lite Sample (9) compared to other lamps. As shown at about 510 nanometers or optimum wavelength, the photopic lumens and scotopic lumens are about 0.0050 and about 0.0115 respectively with a scotopic lumen to photopic lumen ratio about 2.31. The resulting effective pupil lumens are about 801.169 and the effective pupil lumens per watt are about 44.509.

The process of emulsifying the phosphors comprises of creating a binder with de-ionized water and polyethylene chloride in a ratio of 1.5 kilograms of polyethylene chloride to 100 liters of water and 3 kilograms of adhesive slurry. This is mixed at 100 revolutions per minute for three hours. After the binder has blended, 30 kilograms of phosphors that have been previously measured in the above proportions are added to the binder. A 15% ammonia water solution is added until the pH is elevated to 9, and the mixture is blended for three hours at 100 rpm. At completion of the blending the mixture is filtered through a #200 stainless steel mesh net and is suitable for coating fluorescent lamps.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description are efficiently attained and since certain changes may be made in the above construction without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all

statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

Now that the invention has been described,